DOCUMENT RESUME

ED 145 929 PS 009 587

AUTHOR Jusczyk, Peter W.; Thompson, Elizabeth
TITLE Perception of a Phonetic Contrast in Multisyllabic Utterances by Two-Month Old Infants.
SPONS AGENCY National Research Council of Canada, Ottawa (Ontario).
PUB DATE Mar 77
NOTE 24p.; Paper presented at the Biennial Meeting of the Society for Research in Child Development (New Orleans, Louisiana, March 17-20, 1977)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Auditory Discrimination; *Auditory Perception; *Aural Stimuli; *Infant Behavior; *Infants; Language Development; Perceptual Development; *Phonetics; Research
IDENTIFIERS *Speech Perception

ABSTRACT

This study explored three aspects of the 2-month-old's perception of multisyllabic utterances. Questions addressed were: (1) Do infants perceive phonetic contrasts occurring either in the initial (Bada-Gada) or medial (Daba-Daga) positions of multisyllabic utterances; (2) Are infants more likely to perceive these contrasts in stressed as opposed to unstressed syllables; and (3) Will infants detect a difference between two stress patterns? Thirty-six infants, 6 to 9 weeks old, were exposed to one of three conditions of bisyllabic stimuli. Each subject participated in two different sessions. Responses were measured by changes in sucking rate. Results indicated that: (1) Two-month-olds are sensitive to place-of-articulation differences occurring in either the initial or medial positions of multisyllabic stimuli; (2) Whether the contrast occurred between stressed or unstressed syllables has little or no effect on the infant's ability to detect it; (3) Infants as young as two months of age detect differences between stress patterns. (Author/SB)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

ED145929

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

Perception of a Phonetic Contrast in Multisyllabic Utterances by Two-Month Old Infants

Peter W. Jusczyk and Elizabeth Thompson

Dalhousie University

Halifax, Nova Scotia

B3H 4J1

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Peter W. Jusczyk

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

PS 009587

Draft: Please do not quote without permission

Running Head: Infants' Perception of Multisyllables

A version of this paper was presented at the Biennial meeting of the Society for Research in Child Development, March 19, 1977; New Orleans Louisiana.

Abstract

In the present study, three aspects of the two-month old's perception of multisyllabic utterances were explored. First, do infants perceive phonetic contrasts occurring either in the initial (Bada-Gada) or medial (Daba-Daga) positions of multisyllabic utterances? Second, are infants more likely to perceive these contrasts in stressed as opposed to unstressed syllables? Third, will infants detect a difference between two stress patterns? Our results indicate the following: (1) Two-month olds are sensitive to place-of-articulation differences occurring in either the initial or medial positions of multisyllabic stimuli; (2) Whether the contrast occurred between stressed or unstressed syllables had little or no effect on the infant's ability to detect it; (3) Infants as young as two-months old respond to differences between stress patterns.

Introduction

For most of its brief history, the study of speech perception in human infants has been focused on the variety of contrasts that infants are capable of perceiving (e.g., Eimas, 1975; Eimas, Siqueland, Jusczyk & Vigorito, 1971; Morse, 1972; Trehub, 1976). While this line of research has been fruitful, it has dealt only with one aspect of the development of speech perception, namely, the ability to distinguish single syllables on the basis of initial segment differences. However, these kinds of distinctions represent only a small subset of those which the infant will have to make if he is to become a successful perceiver of speech. In fact, the speech sounds which infants hear from adults often differ in their medial or final segments, as well as their initial ones. Moreover, many of the words which adults use have more than one syllable, and each syllable may not be enunciated to the same degree (i.e., some syllables are stressed and others are unstressed). At the present time, we know very little about the extent to which the infant's perceptual system is capable of coping with the information present in multisyllabic utterances.

Our previous research (Jusczyk, 1977) has demonstrated that infants are sensitive to differences between initial segments (dab versus gab) and final segments (bad versus bag) of single syllables. Thus, given that infants do appear to process more than just the initial segment of a syllable, we might expect that they would be sensitive to contrasts between segments of different multisyllables. However, the perception of phonetic contrasts in multisyllables is complicated by a number of factors. One such factor is the effect that embedding a phonetic

contrast in the middle of an utterance may have on the infant's ability to perceive it. A second consideration is the presence in multisyllabic words of suprasegmental features of speech such as stress patterns. Stress is produced by increasing, either singly or in combination, a syllable's pitch, duration, or intensity (Fry, 1958; Lehiste, 1970; Lieberman, 1960). While the factors which give rise to the adult's perception of stress differences have been studied (e.g., Fry, 1958; McClean & Tiffany, 1973; Morton & Jassem, 1965), little attention has been given to the question of how stress differences might affect the adult's (or the infant's) perception of phonetic contrasts.

It is not unreasonable to suppose that one effect of stress may be to enhance the perception of a syllable by calling more attention to it. Indeed, we often act as if this were the case when we attempt to clarify a statement by stressing the misunderstood element. Developmental psychologists also have implied that stress directs attention to an item by suggesting that stress plays an important role in what words a child learns first (Blasdell & Jensen, 1970; Brown & Fraser, 1964; Miller & Ervin, 1964). If stress really does serve to highlight particular item, then we might expect that infants would be more likely to perceive differences between stressed syllables than unstressed ones.

In the present study, we explore aspects of the two-month old's perception of stop consonant differences in multisyllabic utterances. Three issues were of primary concern to us. First of all, does position within an utterance affect the infant's ability to detect a phonetic contrast between two multisyllables? Consequently, we test the

perception of the same place-of-articulation difference ([b] versus [g]) both in the initial position (e.g., [Bada] versus [Gada]) and the medial position (e.g., [Daba] versus [Daga]) of a two-syllable utterance. Second, are infants more likely to perceive a given contrast between stressed syllables or unstressed ones? Thus, we compare the infant's ability to detect the same contrast in both stressed (e.g., [Dabá] versus [Dagá]) and unstressed (e.g., [Dába] versus [Dága]) syllables. Third, are infants as young as two-months old sensitive to changes in stress patterns? Previous research on the perception of suprasegmental information by infants has been limited to the study of intonation contours for sentences (Kaplan, 1969). In her study, Kaplan found that eight-month olds, but not four-month olds, are able to perceive intonation contour differences. For this reason, we also investigate the two-month old's capacity to respond to suprasegmental information such as a difference in stress patterns (e.g., [Báda] versus [Badá]).

Method

Procedure.

Each infant was tested individually in a small laboratory room. The infant was placed in a reclining seat which faced a rear projection screen approximately two feet away. An image of a man was displayed on the screen for the entire test session. The projection screen was situated just above a loudspeaker through which the test stimuli were played. Each infant sucked on a blind nipple which was held in place by one of the experimenters who wore headphones and listened to recorded music throughout the test session. A second experimenter in an adjacent

room monitored the apparatus.

The experimental procedure was a modification of the high amplitude sucking technique developed by Siqueland and DeLucia (1969). For each infant, the high amplitude sucking criterion and the baseline rate of high amplitude sucking were established before the presentation of any stimuli. The criterion for high amplitude sucking was adjusted to produce rates of 15 or 30 sucks per minute. After a baseline rate was established, the presentation of stimuli was made contingent upon the rate of sucking. If the time between each criterion response was 1.4 seconds or more, then each criterion response produced one presentation of the stimulus, which had a duration of 650 msec followed by 750 msec of silence. If the infant produced a burst of criterion responses within this 1.4 second interval, timing apparatus was automatically reset and the 1.4 second interval began again.

The criterion for satiation to the first stimulus was a decrement in sucking rate of 25% or more over two consecutive minutes compared to the rate in the immediately preceding minute. At this point, the auditory stimulation was changed without interruption by switching channels on the tape recorder. For infants in the experimental conditions, the change resulted in the presentation of a second acoustically distinct stimulus. For infants in the control condition, the channels on the tape recorder were switched but no acoustic change was made. The post-shift period lasted for four minutes. The infant's sensitivity to the change in auditory stimulation was inferred from comparisons of the response rates of subjects in the experimental and control conditions during the post-shift period.

Stimuli.

Synthetic speech stimuli were prepared at the Haskins Laboratories in the following manner. Actual utterances were recorded and converted into synthetic speech stimuli using the OVE III synthesizer. These synthetic utterances were then digitized using the Haskins PCM system (Cooper & Mattingly, 1969). The output from the PCM system was then used to prepare audio tapes.

Eight different synthetic bisyllabic stimuli were created (Dába, Dabá, Dága, Dagá, Báda, Badá, Gáda, Gadá). Each stimulus consisted of one stressed and one unstressed syllable. For half of the stimuli, the stressed syllable was first (Dába, Dága, Báda, Gáda). For the other half the unstressed syllable was first (Dabá, Dagá, Badá, Gadá). In order to simulate the closure of the second stop consonant, a pause of 78 msec occurred in all the stimuli between the termination of the first syllable and the onset of the second one.

Stressed syllables had durations of 364 msec, and fundamental frequency (pitch) contours which began at 118 Hz, peaked 120 msec later at 130 Hz and then declined to 106 Hz. By contrast, unstressed syllables had durations of 208 msec, and fundamental frequency contours which began at 106 Hz, peaked 65 msec later at 117 Hz and declined to 106 Hz. In addition, the maximum amplitude of the stressed syllables was 5 dB greater than that of the unstressed ones.

The first 65 msec of each syllable represented a transitional period during which time all three formants moved from their starting frequencies to their terminal steady-state values of 777, 1139, 2150 Hz for the first, second, and third formant, respectively. All syllables

had the same first-formant starting values, 388 Hz. The starting values for the second-and third-formants of each [da] were 1744 and 2557 Hz, respectively; while the comparable values for [ba] were 847 and 1902 Hz and those for [ga] were 1707 and 1808 Hz.

Design.

Table 1 shows the within-subjects design employed in the present experiment.

Insert Table 1 about here

All subjects were seen for two sessions. (Mean interval between sessions was 7.1 days; range was 1 to 19 days.) Subjects in Group 1 were presented with stimuli that contrasted in the medial position for both sessions. During one of the sessions, this contrast occurred in a stressed syllable (e.g., Dabá vs. Dagá), and during the other session it occurred in the unstressed syllable (e.g., Dába vs. Dága). Subjects in Group II were treated exactly like Group I except that they were presented with stimuli that contrasted in the initial position for both sessions. By comparison, subjects in Group III received stimuli that were phonetically identical for both sessions. However, during one of these sessions (STRESS CHANGE), the stress pattern was altered following satiation to the first stimulus (e.g., Báda vs. Badá). During the other session (NO CHANGE), subjects were randomly assigned one of the eight bisyllable stimuli for the entire session (e.g., Dába-Dába). The order of test conditions and the order of stimuli within a session were each counter-balanced across subjects.

Apparatus:

A blind nipple was connected to a Grass PT5 volumetric pressure transducer which was coupled in turn to a Type DMP-4A Physiograph. A Schmitt trigger provided a digital output of criterial high amplitude sucking responses. Additional equipment included a Sanyo 4-track stereo tape recorder with a Sanyo speaker, a Lafayette 100 second timer, a power supply, two relays, a counter, and a Physiograph DC-AC preamplifier. Each criterion response activated the 100-second timer for a 1.4 second period or restarted the period. Auditory stimulation at a level of 79 $\pm$ 2 dB (A) spl (approximately 15 dB above the background noise level caused by the ventilation system) was available to the infant whenever the timer was in an "active" state.

Subjects.

The subjects were 36 infants, 15 males and 21 females. Mean age was 7.4 weeks (range: 6 to 9 weeks). In order to obtain data for two complete sessions with 36 infants, it was necessary to test 91. Subjects were excluded from the study for the following reasons: falling asleep (27%) or crying (36%) prior to shift, failure to maintain a minimum criterion sucking rate of 15 responses per minute during the satiation period (13%), ceasing to suck during the course of the experiment (9%), failure to keep the second appointment (6%), and experimenter error (9%).

Results

Figure 1 displays the mean number of high amplitude sucking responses as a function of minutes and experimental groups. For purposes of statistical comparisons, we examined each subject's rate of sucking during five intervals:

Insect Figure 1 about here

baseline minute, third minute before shift, average of minutes one and two before shift, average of minutes one and two after shift, and average of all four minutes after shift. Difference scores were calculated for each subject for the following rate comparisons: (1) acquisition of the sucking response: third minute before shift less baseline; (2) satiation: third minute before shift less average of last two minutes before shift; (3) release from satiation: average of first two minutes after shift less average of last two minute before shift; and (4) release from satiation for full four minutes after shift: average of four minutes after shift less average of last two minutes before shift.

Wilcoxon matched-pairs signed-ranks tests (Siegel, 1956) were used to analyze performance within each type of session. As is usually the case in studies using this procedure, subjects in all sessions acquired the conditioned high-amplitude sucking response and satiated to the first stimulus prior to shift. An indication of subjects' post-shift performance is provided in Table 2. Randomization tests (Siegel, 1956)

Insert Table 2 about here

were used to make comparisons between performance in each of the experimental sessions and that of the NO CHANGE session for both the first-two-minute and full-four-minute periods after shift. The tests indicated reliable ($p<.05$ or better) differences between each of the

experimental sessions and that of the NO CHANGE session for the first-two-minutes after shift. Comparisons of performance for the full-four-minute period yielded similar results with one exception. Group I subjects in the Daba-Daga session, although in the right direction, did not differ reliably ($p<.20$) from the NO CHANGE session for this period.

In order to evaluate the effect of stress on the perception of the phonetic contrast, two kinds of comparisons were made. For the first kind of comparison, the data from Groups I and II were collapsed across groups. Friedman two-way analyses of variance (Siegel, 1956) were then used to compare performance for the session in which the phonetic contrast was stressed to that in which it was unstressed. The results indicated no difference in performance on the stressed versus the unstressed phonetic contrasts for either the first-two-minute for full-four-minute periods after shift. For the second kind of comparison, separate Randomization tests for matched samples (Siegel, 1956) were used to assess performance across type of session for subjects in Groups I and II. In neither group was there any indication that subjects performed reliably better for contrasts between stressed as opposed to unstressed syllables.

Discussion

The present study demonstrates that two-month olds are sensitive to subtle differences between multisyllabic utterances. Firstly, infants are capable of distinguishing, on the basis of a single phonetic feature difference, multisyllables which contrast in either their initial (e.g., Bada versus Gada) or medial (e.g., Daba versus Daga) segments.

Secondly, two-month olds will respond to a change in the stress pattern of a multisyllabic utterance (e.g., Daga versus Daga). Moreover, there was no indication in the present study that stress pattern interacts with the perception of a stop consonant contrast (i.e., subjects were no more likely to detect a contrast in a stressed as opposed to unstressed syllable).

The present results extend previous developmental findings in two directions. First, they indicate that infants can detect place-of-articulation differences not only for different positions in single syllable stimuli (Eimas, 1974; Jusczyk, 1977; Miller, Morse & Dorman, 1977; Morse, 1972), but for the initial and medial positions of multisyllabic stimuli as well. Second, in contrast to Kaplan's (1969) findings for the perception of intonation contours, it was shown that infants as young as two months of age are sensitive to suprasegmental speech information such as stress patterns.

In view of the claims made by a number of developmental psycholinguists (Blasdell & Jensen, 1970; Brown & Fraser, 1964; Miller & Ervin, 1964), the finding that stress position had little or no effect on the infant's ability to perceive the phonetic contrast was somewhat surprising. One might have expected that the increase in pitch, intensity, and duration associated with the stressed syllables might have made them more salient, and thus, differences between them would have been more detectable. There are several possible explanations for our results. It may be the case that as long as a syllable is at an audible level, stress does not affect the perception of its elements. Thus, we would have to look for another explanation as to

why the language learning child often omits unstressed syllables in his productions. Alternatively, stress may interact with the perception of some contrasts but not others. In the present study, we looked only at stop consonants. These phones are all characterized by a period of complete closure of the vocal tract and this alone may make them quite prominent to a listener. Perhaps stress interacts with the perception of other phones, such as those characterized by less abrupt transitions (e.g., glides).

One additional result which deserves comment is the failure to find a reliable difference between the NO CHANGE sessions and one of our experimental sessions (i.e., the Dabá-Daga session) for the full-four-minute period after shift. In fact, an examination of the mean recovery in response rates for the full-four-minute period after shift for Groups I and II (see Table 2) shows them to be generally lower than those observed using single-syllable stimuli differing in place-of-articulation (Eimas, 1974; Jusczyk, 1977). One possible explanation for the reduced level of responding for the full-four-minute period after shift with multisyllabic stimuli has to do with the novelty of the second stimulus. Proportionally, there is less that is novel about two multisyllabic stimuli differing by a single phonetic feature than there is for a single syllable pair differing by the same feature. For this reason subjects may resatiate to the second stimulus more quickly when multisyllabic stimuli are employed.

In conclusion, the present study has added new information concerning the remarkable capacities that the young infant has available for speech

perception. Not only are infants able to perceive a wide variety of speech contrasts (e.g., Eimas, 1975a, b; Trehub, 1976), but they are capable of detecting information about such contrasts across different positions in a syllable (Jusczyk, 1977) and, as we have shown, in strings longer than a single syllable.

Acknowledgements

This research was supported by grants to the first author from the National Research Council and from the Faculty of Graduate Studies, Dalhousie University. The authors wish to thank Ms. Heather Copan for her assistance in the collection of the data, and also to express their gratitude to Dr. Alvin M. Liberman for his generosity in making the facilities of the Haskins Laboratories available for the preparation of stimulus materials.

REFERENCES

Blasdell, R., & Jensen, P. Stress and word position as determinants of imitation in first-language learners. Journal of Speech and Hearing Research, 1970, 13, 193-202.

Brown, R., & Fraser, C. The acquisition of syntax. In C.N. Cofer & B.S. Musgrave (Eds.), Verbal behavior and learning: problems and processes. New York: McGraw-Hill, 1963.

Cooper, F.S., & Mattingly, I.G. A computer-controlled PCM system for the investigation of dichotic speech perception. Journal of the Acoustical Society of America, 1969, 46, 115 (A).

Eimas, P.D. Auditory and linguistic processing of cues for place of articulation by infants. Perception & Psychophysics, 1974, 16, 513-521.

Eimas, P.D. Auditory and phonetic coding of the cues for speech: Discrimination of the [r-l] distinction by young infants. Perception & Psychophysics, 1975, 18, 341-347 (a).

Eimas, P.D. Speech perception in early infancy. In L.B. Cohen & P. Salapatek (Eds.), Infant perception. New York: Academic Press, 1975 (b).

Eimas, P.D., Siqueland, E.R., Jusczyk, P., & Vigorito, J. Speech perception in infants. Science, 1971, 171, 303-306.

Fry, D.B. Experiments in the perception of stress. Language and Speech, 1958, 1, 126-152.

Jusczyk, P.W. Perception of syllable-final stop consonants by two-month old infants. Perception & Psychophysics, 1977, 21,

Kaplan, E.L. The role of intonation in the acquisition of language. (Unpublished Ph.D. dissertation, Cornell University, 1969), Dissertation Abstracts International, 1970, 30, 3407B (University Microfilms No. 69-20, 977).

Lehiste, I. Suprasegmentals. Cambridge, Mass.: The M.I.T. Press, 1970.

Lieberman, P. Some acoustic correlates of word stress in American English. Journal of the Acoustical Society of America, 1960, 32, 451-454.

McClean, M.D., & Tiffany, W.R. The acoustic parameters of stress in relation to syllable position, speech loudness and rate. Language and Speech, 1973, 16, 283-290.

Miller, C., Morse, P.A., & Dorman, M.F. Cardiac indices of infant speech perception: orienting and burst discrimination. Quarterly Journal of Experimental Psychology, 1977, 29,

Miller, W.R., & Ervin, S. The development of grammar in child language. In U. Bellugi & R. Brown (Eds.), The acquisition of language. Monographs of the Society for Research in Child Development, 1964, 29, 9-35.

Morse, P.A. The discrimination of speech and nonspeech stimuli in early infancy. Journal of Experimental Child Psychology, 1972, 14, 477-492.

Morton, J., & Jassem, W. Acoustic correlates of stress. Language and Speech, 1965, 8, 159-181.

Siegel, S. Nonparametric statistics for the behavioral sciences. New York: McGraw-Hill, 1956.

Siqueland, E.R., & Delucia, C.A. Visual reinforcement of non-nutritive sucking in human infants. Science, 1969, 165, 1144-1146.

Trehub, S.E. The discrimination of foreign speech contrasts by infants and adults. Child Development, 1976, 47, 466-472.

Table 1

Design

	Condition A	Condition B
Group I (n=12)	DABA-DAGA	DABA-DAGA
Group II (n=12)	BADA-GADA	BADA-GADA
Group III (n=12)	Stress Change (e.g., BADA-GADA)	No Change (e.g., BADA-BADA)

Table 2

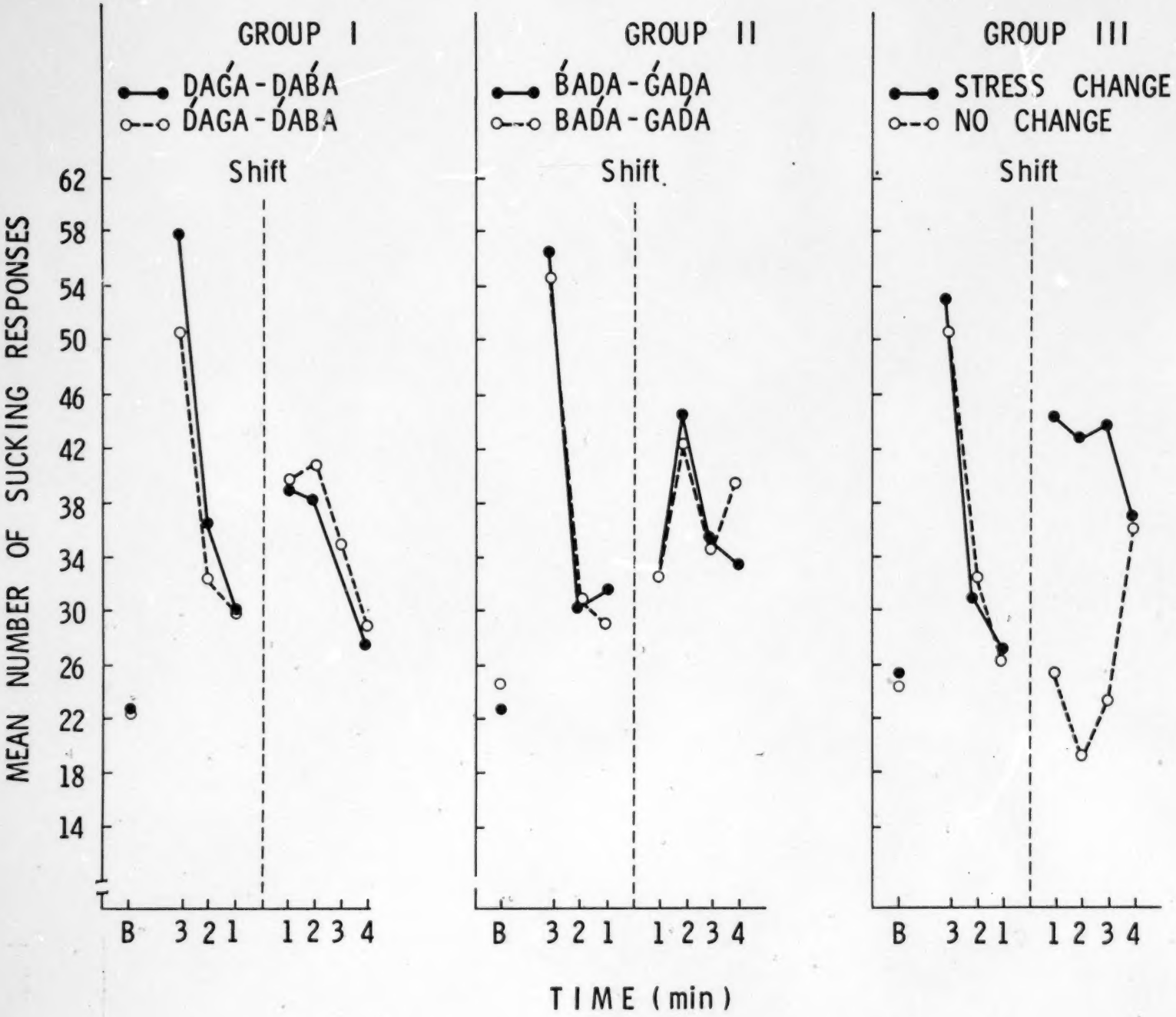
Mean Change in Response Rate After Shift

		Release from satiation first-two-minutes after shift	Release from satiation full-four-minutes after shift
Group I	Daba-Daga	5.50*	1.31
	Daba-Daga	8.88*	4.65*
Group II	Bada-Gada	8.17*	6.02*
	Bada-Gada	7.08*	6.92*
Group III	STRESS CHANGE	14.21*	12.60*
	NO CHANGE	-6.75	-3.08

*Indicates a reliable difference of $p<.05$ or better when compared against performance in the NO CHANGE session.

Figure Caption

Figure 1. Mean number of high amplitude sucking responses as a function of time and experimental group. Time is measured with reference to the moment of the stimulus shift, marked by the vertical dashed line. The baseline rate of sucking is indicated by the letter "B".


GROUP I
DÁGA - DÁBA
DÁGA - DÁBA
Shift
GROUP II
BÁDA - GÁDA
BÁDA - GÁDA
Shift
GROUP III
STRESS CHANGE
NO CHANGE
Shift
MEAN NUMBER OF SUCKING RESPONSES
62
58
54
50
46
42
38
34
30
26
22
18
14
B 3 2 1 1 2 3 4
TIME (min)